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This is a final report of the project titled "Problems related to conservation laws - Phase transions and viscoelasticity". In this project I considered the dynamical aspects of a phase transtion problem and the stability issue of waves for viascoelastic materials with memory.

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Final Report

In this grant I studied two subjects, a phase transition problem and equations related to viscoelastic materials with memory. In what follows, I summarize the results in both areas.

Phase Transition Problem

I mainly considered the equation

$$(0.1) \qquad u_{tt} = \sigma(u_x)_x + \nu u_{xxt} - \eta u_{xxxx}$$

with boundary conditions

$$(0.2) \qquad u(0,t) = 0, \quad \sigma(u_x(1,t)) + \nu u_{xt}(1,t) - \eta u_{xxx}(1,t) = P,$$

$$(0.3) \qquad u_{xx}(0,t) = 0, \quad u_{xx}(1,t) = 0.$$

Equation (0.1) models a bar which goes through a phase transition. The boundary conditions (0.2) show that the bar is under a soft loading device. The boundary conditions (0.3) are the natural boundary conditions for the corresponding variational problem. The terms with the coefficients ν and η are called viscosity and capillarity terms, respectively. We assume that σ is a nonmonotone function of its argument. The main results that I obtained are summarized as follows:

1. the existence of global solutions,

2. the bifurcation and dynamic stability of steady state solutions,

3. the connecting orbit problem,

4. the existence of slow motions.

Viscoelasticity

I studied the existence and nonexistence of global solutions for a semilinear integral equation with memory which can be reduced to a system of quasilinear equations.

I also considered the nonlinear stability of rarefaction waves and the travelling wave solutions. Also I discussed the existence of travelling wave solutions for systems with nonconvex constitutive relations.

List of Publications

1. On an inviscid approach to phase transition problem, *Adiabatic Waves in Liquid-Vapor Systems (G.E.A. Meier and P.A. Thompson eds.)*, Springer-Verlag, 79-89.

2. (with J.H. Lightbourne) Global existence and blowup for a semilinear integral equation, J. Integral Equations and Applications 2 (1990),529-546.

3. (with K. Mischaikow) A dynamical system approach to a phase transition problem, J. Differential Equations 94 (1991), 340-378.

4. (with K. Mischaikow) On the slow motions of phase boundaries in the Korteweg theory of capillarity, Dynamic Systems and Applications 1 (1992), 441-452.

5. (with K. Mischaikow) On a global dynamics of a phase transition problem, *Free boundary problems involving solids (J.H. Chadam and H. Rasmussen eds.)*, Pitsman, 226-231.

6. (with K. Mischaikow) A phase transition problem-A dynamical systems approach, *Viscous profiles and numerical methods for shock waves (M. Shearer ed.)*, SIAM, 73-78.

7. (with H. Fujimoto) On dynamical aspects of a phase transition problem, *(Transactions of the ninth army conference on applied mathematics and computing)*, 427-435.

8. The Korteweg theory of capillarity and the phase transition problems, *(Transactions of the tenth army conference on applied mathematics and computing)*, 131-142.

9. (with D. Li) Solutions for two dimensional system for materials of Korteweg type, to appear in SIAM J. on Math. Anal.

10. Nonlinear stability of rarefaction waves for a viscoelastic materials with memory, to appear in Transactions of American Mathematical Society.

11. (S. Kawashima) Nonlinear stability of travelling wave solutions for viscoelastic materials with memory, submitted for publication.

12. (S. Kawashima) Existence of travelling wave solutions for materials with memory, submitted for publication.

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